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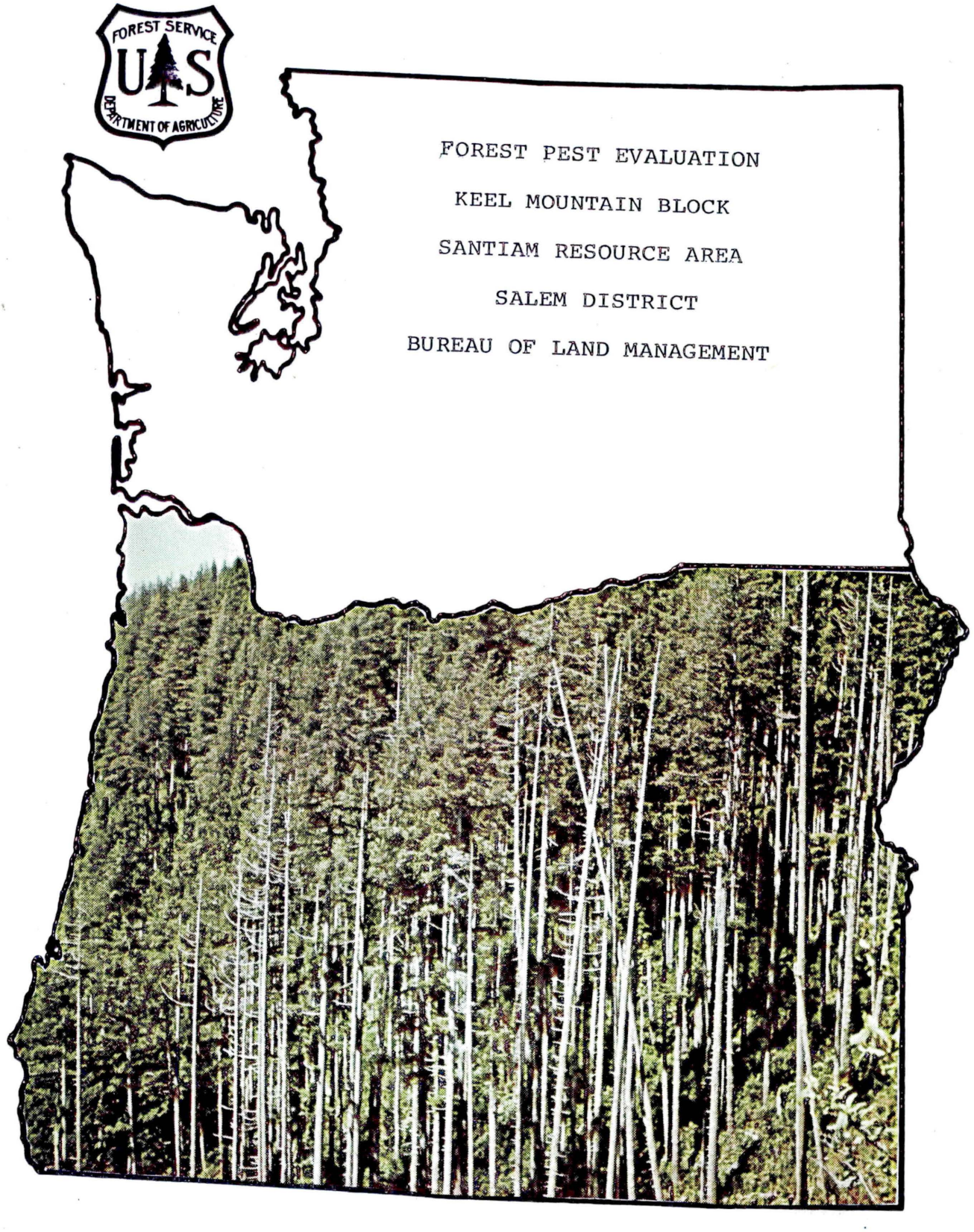
Forest Pest Management
Pacific Northwest Region



FOREST PEST EVALUATION

KEEL MOUNTAIN BLOCK

SANTIAM RESOURCE AREA

SALEM DISTRICT

BUREAU OF LAND MANAGEMENT

FOREST PEST EVALUATION, KEEL MOUNTAIN BLOCK SANTIAM RESOURCE AREA, SALEM DISTRICT, BUREAU OF LAND MANAGEMENT

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INTRODUCTION

During the weeks of April 25-29 and May 9-13, 1983, a Forest Pest Management pathology crew did a pest survey of the Keel Mountain Block, Santiam Resource Area, Salem District, Bureau of Land Management (T. 12 S., R. 1 E., sec. 13). District personnel had noticed tree mortality and blowdown in this area and suspected that laminated root rot (caused by the fungus *Phellinus weirii*) was responsible. They requested a biological evaluation to determine general distribution of disease and insect activity in the unit, quantify loss, and provide pest management recommendations. A portion of the stand on the unit is being considered for a commercial thinning in the near future, and the silviculture staff is anxious to incorporate pest control strategies into the treatment plan.

METHODS

The unit was surveyed systematically using a variable plot cruise. A Spiegel-Relaskop was employed to define plots (basal area standard = 40) and plots were located on a 10x10 chain grid across the block. In all plots, the following information was recorded for each "in" tree: species, DBH, general condition (live, dead, standing, down) and, where appropriate, diseases or insects present. Two roots on opposite sides of each recently dead or symptomatic tree were excavated to a distance of 3 feet from the root collar and examined for evidence of stain, decay, or fungus mycelia. Roots and butts of old dead trees were dissected to determine character of wood decay. Trunks were examined for signs and symptoms of heart rot and crowns were examined for evidence of foliage diseases and mistletoes. Bark was removed from the stems of bark beetle-infested trees to expose galleries for beetle species determination. From data collected in plots, mean basal area and number of trees per acre by tree species, DBH class, and condition were calculated.

In addition to collecting data in plots, the survey crew reconnoitered areas between plots and lines and stratified the unit into generally healthy and lightly, moderately, or severely root-diseased areas that were delineated on a unit map.

RESULTS AND DISCUSSION

The survey block (Figure 1) is 640 acres in size and is characterized by relatively level benches bisected by steep-walled stream drainages. The northeast corner of the unit rises abruptly toward the peak of Keel Mountain. The stand on the unit contains a mosaic of age classes ranging from approximately 20 to 50 years old (Figure 1). Records indicate that the current stand originated from natural seeding following the several harvest entries. Much of the southwest and central portion of the unit was precommercially thinned in the early 1970's, and an area in the southeastern part of the block was thinned more recently. The stand is composed of an almost equal mixture of Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*). Stump evidence indicates that western redcedar (*Thuja plicata*) was an important component of the original forest, though virtually no redcedar occurs in the present stand. Stocking is quite variable with densely stocked patches interspersed with open areas. Mean basal area and numbers of trees per acre for the survey block are summarized by species, DBH class, and condition in Table 1.

As expected, laminated root rot was the most common and damaging disease in the survey area. Other pests occurring at significant levels were Armillaria root rot (caused by *Armillaria mellea*), hemlock dwarf mistletoe (*Arceuthobium tsugense*), and Douglas-fir beetle (*Dendroctonus pseudotsugae*). Each is discussed in more detail in the following sections.

LAMINATED ROOT ROT - Infection by *P. weirii* was detected on 5.4 percent of the Douglas-fir and 6.8 percent of the western hemlock in the survey area. Most affected Douglas-fir (80 percent) were dead or windthrown, while most affected western hemlocks were alive and standing, though they exhibited crown symptoms. Plots that contained laminated root rot averaged 23 percent fewer trees than unaffected plots. The disease was distributed thoughout the stand but was most severe in the southwest 1/8th (Figure 2). Laminated root rot was identified readily by the typical wood decay that separates easily at the growth rings, the reddish, whiskery setal hyphae that appear between the sheets of rotted wood, and the grayish crusty ectotrophic mycelia on root bark.

Laminated root rot is a particularly dangerous disease because of its devastating effect on Douglas-fir hosts and because the causal agent is persistent on the site. The fungus can survive for up to 50 years in roots of old stumps and infect, via root contacts, hosts that become established on the site. Infection centers develop and increase in size due to subsequent spread from tree to tree along roots. Thus, laminated root rot not only poses a continuing threat to the existing stand on the Keel Mountain Block but also, if not treated, a potential danger for further rotations.

Recommended control for laminated root rot is to harvest all susceptible hosts in infection centers and a 50-foot buffer around each and (1) mechanically remove all inoculum (infected roots and stumps) with heavy equipment or (2) leave inoculum but replant with immune, resistant, or intermediately susceptible tree species that are adapted to the site. Mechanical removal of inoculum is effective and allows the manager to replant with any tree species desired, but it is expensive, difficult on steep terrain, and may contribute to substantial soil damage. Unless an infected stand is on a level, high-quality site with a relatively light soil, tree species manipulation in disease centers is usually a more viable control alternative.

In the Keel Mountain area, tree species by increasing degree of susceptibility are IMMUNE - hardwoods; RESISTANT - western redcedar; INTERMEDIATELY SUSCEPTIBLE - western hemlock; HIGHLY SUSCEPTIBLE - Douglas-fir. If only immune species are planted on an infected site and grown for a rotation (50 years or more), *P. weirii* will die out, and a highly susceptible species such as Douglas-fir could be grown in the following rotation with almost no likelihood of additional losses. If resistant species are used, there should be much the same result, although there may be a small amount of infection and retention of the pathogen. If intermediately susceptible species are grown for a rotation, they should suffer relatively little apparent damage. However, many may be infected, a few may die, and the disease will be maintained on the site. Planting with highly susceptible species in the subsequent rotation will result in a renewed and probably magnified disease problem.

ARMILLARIA ROOT ROT - Armillaria root rot was found affecting 1.0 percent of the Douglas-fir and 2.1 percent of the western hemlocks in the survey block. The disease was especially severe in the south-central part of the area where there were many chlorotic trees and soil conditions appeared to indicate that there had been a particularly intense burn following logging (Figure 2). Armillaria root rot was identified based on the characteristic thick, white mycelial fans under the bark of affected host roots and lower stems, the associated rhizomorphs, and the stringy, yellow decay.

Armillaria mellea survives as a saprophyte in old stumps and roots and can infect nearby trees via root contacts or by growing a short distance through the soil. Usually on the west side of the Cascades, *A. mellea* is a weak pathogen that infects and helps to kill stressed or injured trees. Where site conditions produce many such trees (as in the south-center of the Keel Mountain Block), Armillaria root rot can be significantly damaging. It also commonly affects trees stressed by another disease such as laminated root rot. Disease management for Armillaria root rot should involve (1) attempting to ameliorate site conditions that contribute to tree stress, (2) favoring tree species and stock from seed sources that are well adapted to the site, and (3) controlling other pests that weaken trees.

HEMLOCK DWARF MISTLETOE - Infection by hemlock dwarf mistletoe was detected in 5.5 percent of the western hemlocks examined in the Keel Mountain Block. Patches of infected trees occurred throughout the unit but infection was heaviest in the western half. Mistletoe was identified by the branch swellings with small yellow-green plants and by the characteristic witches'-brooms on the hosts.

Dwarf mistletoes are parasitic higher plants that obtain water and photosynthates from their hosts. They are spread by forcibly discharged seeds that are cast out from infected overstories and fall onto susceptible trees in the understory. Most dwarf mistletoes are relatively host specific and, in the Keel Mountain area, hemlock dwarf mistletoe will infect only western hemlock.

Dwarf mistletoes can cause growth loss, distortion, and even mortality of infected trees. However, hemlock dwarf mistletoe in the Pacific Northwest Region has been found to be considerably less damaging to its hosts than most other species of dwarf mistletoe. In fact, unless infection is very severe or infected trees are managed on very long rotations (180 years+), loss attributable to hemlock mistletoe is usually minor. Nevertheless, it is recommended

that, whenever possible, mistletoe be eliminated from infected stands at the time of final harvest by thorough clearcutting of all infected trees. During thinnings, uninfected trees or trees with light infections in the bottoms of their crowns should be favored for retention over heavily infected trees.

DOUGLAS-FIR BEETLE - Scattered Douglas-firs that had been infested by Douglas-fir beetles were found throughout the survey area. Douglas-fir beetles were identified by their long, vertical adult galleries with alternating groups of horizontally branching larval galleries.

For the most part, Douglas-fir beetles are not primary tree killers. Rather, they usually attack and breed in severely weakened or windthrown trees. In the Keel Mountain Block, they were usually found in trees infected by *P. weirii* or in some of the larger windthrown or broken trees in the creek bottoms.

Control of Douglas-fir beetles is attained by promoting and maintaining a vigorous stand. Root disease control and salvage of injured and windthrown trees before they can be infested will limit loss from beetles.

MANAGEMENT RECOMMENDATIONS

The following specific pest management recommendations are suggested for the Keel Mountain Block:

(1) In the upcoming commercial thinning, favor mistletoe-free or lightly mistletoe-infected western hemlock for leave trees in the southwest 1/8th of the area and around obvious laminated root rot pockets in other parts of the stand. Salvage all obviously infected Douglas-firs and also harvest all Douglas-firs within 30 feet of infected trees. Use care to minimize wounding of hemlock residuals.

(2) At the time of final harvest (in 15 to 20 years), clearcut the stand. Do not leave any mistletoe-infected western hemlock standing on the unit.

(3) Following harvest, regenerate the southwest 1/8th of the unit and obvious infection centers in the remainder of the block with tree species immune, resistant, or intermediately susceptible to laminated root rot. Our choices would be: first, red alder; second, western redcedar; and third, western hemlock. If hemlock is used, do not plan to plant Douglas-fir in the subsequent rotation.

(4) In choosing planting stock for the unit, be sure to obtain local seed source material of good quality to avoid possible Armillaria root rot problems in the future.

(5) Consult with a soils expert concerning the advisability of fertilizing the area in the south center of the unit that now exhibits high levels of Armillaria root rot.

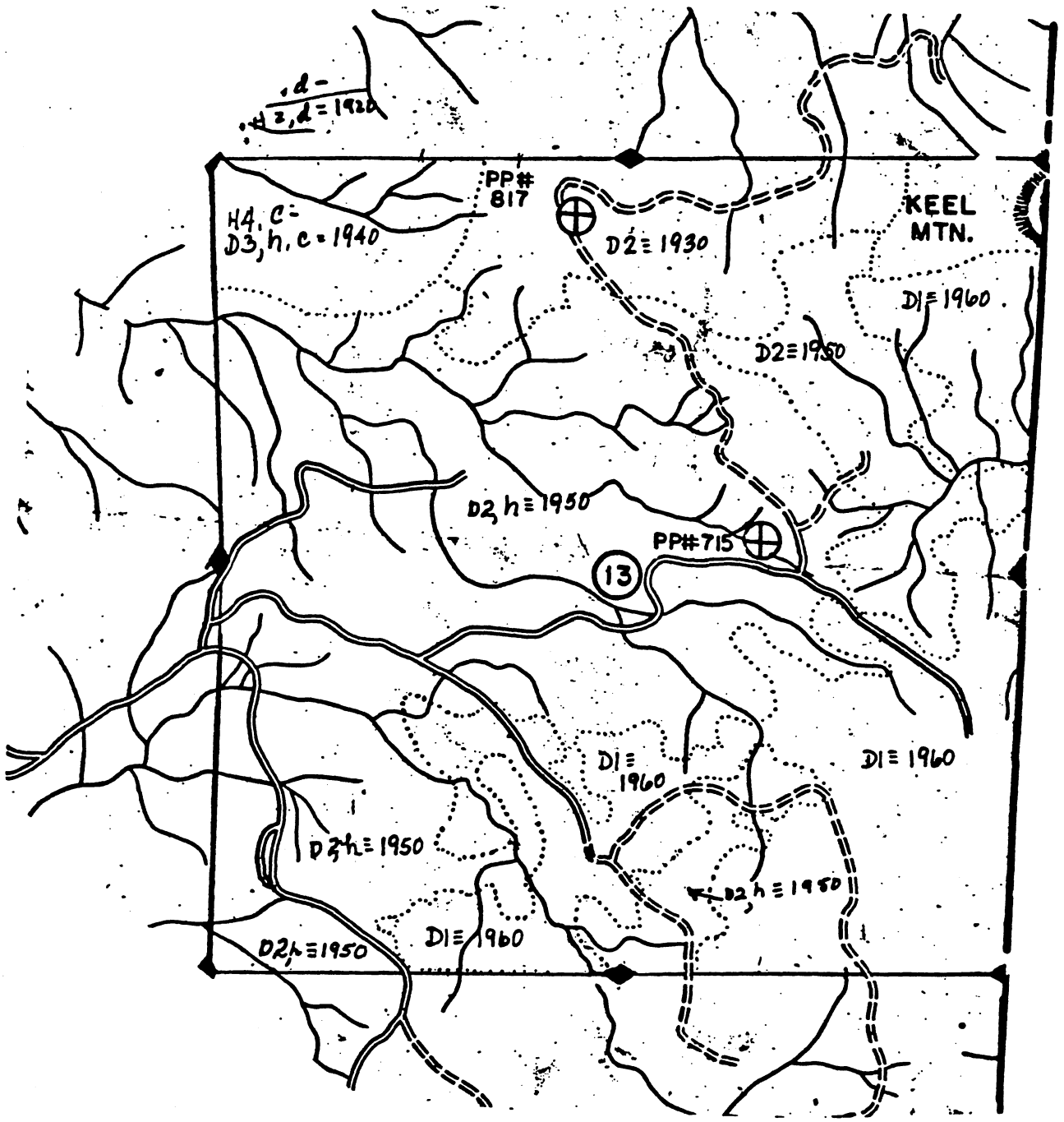

Figure 1. Keel Mountain Block showing location of different age classes in stand.

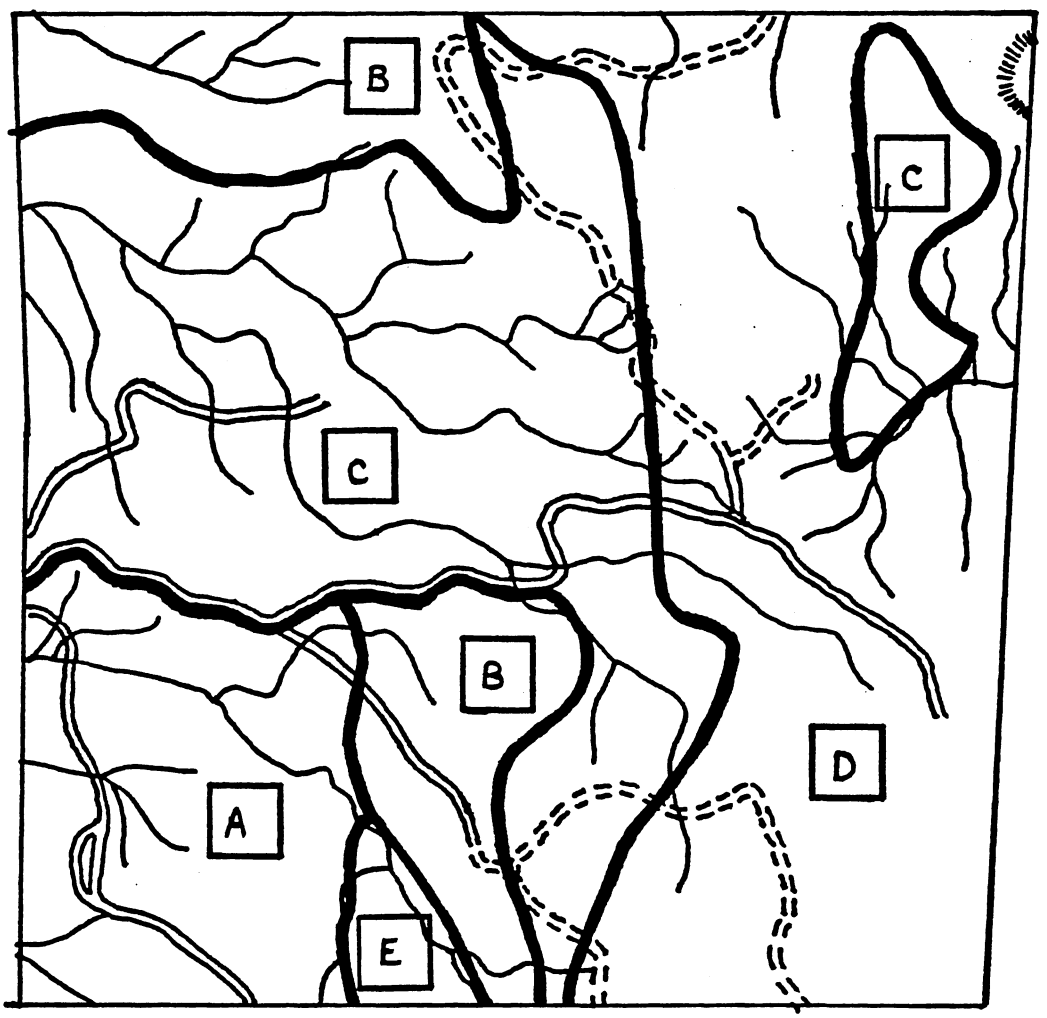

Figure 2. Keel Mountain Block stratified by root disease intensity: A - severe laminated root rot; B - moderate laminated root rot; C - light laminated root rot; D - generally healthy; E - considerable Armillaria root rot.

Table 1: Mean numbers of trees and basal area (in parenthesis) per acre by species, diameter class, and condition for the Keel Mountain Block.

DBH Class	DOUGLAS-FIR			WESTERN HEMLOCK	
	Healthy	Root Diseased	Snow, Wind, or Animal Damaged	Healthy	Root Diseased
6	36.7 (7.2)	3.3 (0.7)	3.3 (0.7)	10.0 (2.0)	3.3 (0.7)
8	39.4 (13.8)	1.9 (0.7)	1.9 (0.7)	11.3 (3.9)	3.8 (1.3)
10	15.6 (8.5)	0	0	26.6 (11.8)	1.2 (0.7)
12	7.5 (5.9)	1.6 (1.4)	0.8 (0.7)	16.7 (13.1)	0
14	8.0 (8.5)	1.2 (1.4)	0	10.4 (11.1)	0
16	5.2 (7.2)	0.5 (0.7)	0.5 (0.7)	5.2 (7.2)	0
18	4.1 (7.2)	0	0	3.0 (5.2)	0
20	0.9 (2.0)	0	0.3 (0.7)	0.9 (2.0)	0
22	0.5 (1.3)	0	0	0.2 (0.7)	0
24	0.2 (0.7)	0	0	0.2 (0.7)	0
26	0.2 (0.7)	0	0	0.2 (0.7)	0
Total All Classes	118.3 (63.0)	8.5 (4.9)	6.8 (3.5)	84.7 (58.4)	8.3 (2.7)

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